The study on applicability of an improved SPH algorithm for multiphase flows based on Riemann solution

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Abstract

Discontinuities of density, viscosity and pressure exist in the multiphase flow interface, and the numerical simulation using the traditional SPH model often causes pressure oscillation, which is a big problem in the application of SPH. An new SPH model for multiphase flows based on Riemann solution is presented. Using the advantage of Riemann solution in dealing with the contact discontinuity, we introduce the SPH multiphase flow model. For the sake of accurately solving the physical viscosity of multiphase fluid and decreasing Riemann dissipation, the momentum equation of the Riemann form is improved. In the model, we combine the Adami fixed particle wall-boundary with the one-sided Riemann problem to impose wall boundary, and consider the influence of surface tension on the small-scale interface. The new model without adding artificial dissipation can simulate the physical viscousity of multiphase flow. In order to verify the ability of the improved model in dealing with the multi-phase interface, the squared droplet oscillating problem is simulated first. Afterwards, Rayleigh-Taylor instability and bubble floating multi-phase flow problems are simulated. The results is illustrated in Figure 1. The interface is clearly capture and the results are in good agreement with the literature, which proved that the improved multiphase flow SPH model can stably and effectively deal with the multiphase flow problem of density ratio and viscosity ratio across the interface up to 1000 and 100.

Keywords: Multiphase flow, smooth particle method, Riemann solution, discontinuous interface

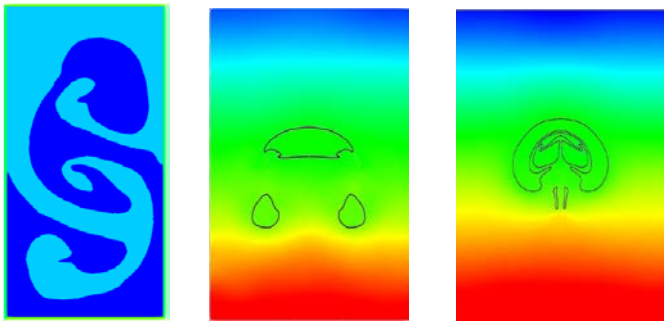

Fig.1 The results of Rayleigh-Taylor instability, bubble floating problems

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